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Engineering & Scientific Consulting

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Professional Profile

Dr. Hardin specializes in understanding the complex chemical dynamics that underpin practical consumer and industrial products, including nanomaterials and their applications. His expertise is in the design and evaluation of catalysts for energy production and chemical conversion reactions used in fuel-cells, electrolyzers, exhaust treatment systems, chemical manufacturing, and air batteries - among others. He has extensive experience in catalysis, surface science, colloidal science, mesoporous materials, nanomaterials synthesis, and chemical analysis. He has applied this knowledge to assist clients across many markets in matters of product performance, safety, durability, and recalls as well as litigation and arbitration support.

He is a trained materials scientist and electrochemist who utilizes engineering principles to integrate his fundamental knowledge of chemistry and materials physics to address challenges in the energy, automotive, medical, and environmental industries. This approach has enabled his work to advance the understanding of the mechanistic underpinnings of oxygen electrochemistry, nanoparticle drug delivery, and urea remediation. He regularly utilizes many characterization methods to probe surface, bulk, structural, and chemical properties of materials including electron microscopy, X-ray photoelectron spectroscopy (XPS), chemical titrations, X-ray diffraction (XRD), nitrogen sorption (BET), vibrational spectroscopy (FTIR/NIR/UV-VIS/Raman), thermogravimetric analysis with differential scanning calorimetry (TGA-DSC), dynamic light scattering (DLS), and zeta-potential measurements.

Dr. Hardin has conducted extensive studies on the influence of material composition and chemical environment on performance, reliability and safety of catalytic systems. This began with design of dynamic chemical systems involving metal ions in aqueous and chelating environments in his doctoral research at the University of Texas, where he was co-advised by an analytical chemist and a chemical engineer. With one foot planted firmly in chemistry and the other in engineering, he engineered metal and metal oxide nanoparticles for energy generation in metal-air batteries and regenerative fuel cells, and developed inexpensive replacements for the iridium-based electrodes used in the chlor-alkali process. In the course of developing these materials, he elucidated novel reaction mechanisms involved in oxygen electrochemistry and helped pioneer a deeper understanding of the design and selection criteria for catalytic processes. Dr. Hardin's research has been published in *Nature Materials*, *Nature Communications*, and journals of the American Chemical Society and the Royal Society of Chemistry.

Academic Credentials & Professional Honors

Ph.D., Materials Science & Engineering, University of Texas, Austin, 2017

B.S., Materials Science & Engineering, Georgia Institute of Technology (Georgia Tech), summa cum laude, 2010

Prior Experience

Graduate Research Assistant, University of Texas at Austin, 2010-2017

Professional Affiliations

American Chemical Society

Materials Research Society

The Electrochemical Society

Publications

<https://scholar.google.com/citations?user=G08lcsUAAAAJ>

Mefford, J. T.; Kurilovich, A. A.; Saunders, J.; Hardin, W. G.; Abakumov, A. M.; Forslund, R. P.; Bonnefont, A.; Dai, S.; Johnston, K. P.; Stevenson, K. J. "Decoupling the Roles of Carbon and Metal Oxides on the Electrocatalytic Reduction of Oxygen on La_{1-x}Sr_xCoO_{3-δ}; Perovskite Composite Electrodes" *Physical Chemistry Chemical Physics*. 2019.

Forslund*, R. P.; Hardin*, W. G.; Rong, X.; Abakumov, A. M.; Filimonov, D.; Alexander, C. T.; Mefford, J. T.; Iyer, H.; Kolpak, A. M.; Johnston, K. P.; Stevenson, K. J. "Exceptional Electrocatalytic Oxygen Evolution via Tunable Charge Transfer Interactions in La_{0.5}Sr_{1.5}Ni_{1-x}Fe_xO_{4+δ};" *Nature Communications*. 2018.

Forslund, R. P.; Mefford, J. T.; Hardin, W. G.; Alexander, C. T.; Johnston, K. P.; Stevenson, K. J. "Nanostructured LaNiO₃ Perovskite Electrocatalyst for Enhanced Urea Oxidation" *ACS Catalysis*. 2016.

Mefford, J. T.; Rong, X.; Abakumov, A.; Hardin, W. G.; Dai, S.; Kolpak, A. M.; Johnston, K. P.; Stevenson, K. J. "Water Electrolysis on La_{1-x}Sr_xCoO_{3-δ}; Perovskite Electrocatalysts" *Nature Communications*. 2016.

Hardin, W. G.; Mefford, J. T.; Slanac, D. A.; Patel, B. B.; Wang, X.; Dai, S.; Zhao, X.; Ruoff, R. S.; Johnston, K. P.; Stevenson, K. J. "Tuning the Electrocatalytic Activity of Perovskites through Active Site Variation and Support Interactions" *Chemistry of Materials*. 2014.

Mefford, J. T.; Hardin, W. G.; Dai, S.; Johnston, K. P.; Stevenson, K. J. "Anion Charge Storage through Oxygen Intercalation in LaMnO₃ Perovskite Pseudocapacitor Electrodes" *Nature Materials*. 2014.

Hardin*, W. G.; Slanac*, D. A.; Wang, X.; Dai, S.; Johnston, K. P.; Stevenson, K. J. "Highly Active, Nonprecious Metal Perovskite Electrocatalysts for Bifunctional Metal Air Battery Electrodes." *Journal of Physical Chemistry Letters*. 2013.

Slanac, D. A.; Hardin, W. G.; Johnston, K. P.; Stevenson, K. J. "Atomic Ensemble and Electronic Effects in Ag-Rich AgPd Nanoalloy Catalysts for Oxygen Reduction in Alkaline Media." *Journal of the American Chemical Society*. 2012.

Murthy, A. K.; Stover, R. J.; Hardin, W. G.; Schramm, R.; Nie, G. D.; Gourisankar, S.; Truskett, T. M.; Sokolov, K. V.; Johnston, K. P. "Charged Gold Nanoparticles with Essentially Zero Serum Protein Adsorption in Undiluted Fetal Bovine Serum." *Journal of the American Chemical Society*. 2013.

Joshi, P. P.; Yoon, S. J.; Hardin, W. G.; Emelianov, S.; Sokolov, K. V. "Conjugation of Antibodies to Gold Nanorods through Fc Portion: Synthesis and Molecular Specific Imaging." *Bioconjugate Chemistry*. 2013.

Presentations

Hardin, W. G., J. T. Mefford, K. P. Johnston, K. J. Stevenson (2015). "Tuning of Perovskite Oxides Electrochemical Activity for Water Oxidation and Oxygen Reduction" Presented at 249th American Chemical Society National Meeting & Exposition, Denver, CO, Mar. 22-26.

Hardin, W. G., C. T. Alexander, J. T. Mefford, S. Dai, K. P. Johnston, K. J. Stevenson (2015). "Tuning the Electrochemical Activity of Perovskites Through Active Site Variation and Support Interactions" Presented at 2015 Center for Electrochemistry Annual Workshop on Electrochemistry, Austin, TX, Feb. 7-8.

Hardin, W. G., J. T. Mefford, D. A. Slanac, B. Patel, S. Dai, K. P. Johnston, K. J. Stevenson (2014). "Highly Active Perovskite Oxides for Water Oxidation and Oxygen" Presented at 32nd International Conference on the Physics of Semiconductors, Austin, TX, Aug. 10-15.

Hardin, W. G., J. T. Mefford, K. P. Johnston, K. J. Stevenson (2013). "Bifunctional, Non-precious Metal Perovskite Electrocatalysts with High Mass Activities for Water Oxidation and Oxygen Reduction" Presented at 223rd Electrochemical Society Meeting, Toronto, ON, May 12-16.

Hardin, W. G., D. A. Slanac, X. Wang, S. Dai, K. P. Johnston, K. J. Stevenson (2013). "Bifunctional, Non-precious Metal Perovskite Nanocrystal Electrocatalysts with High Mass Activities for Water Oxidation and Oxygen Reduction" Presented at 2013 Materials Research Society Spring Meeting & Exhibit, San Francisco, CA, Apr. 1-5.

Hardin, W. G., J. T. Mefford, D. A. Slanac, X. Wang, S. Dai, K. P. Johnston, K. J. Stevenson (2013). "Bifunctional, Non-precious Metal Perovskite Nanocrystal Electrocatalysts with High Mass Activities for Water Oxidation and Oxygen Reduction" Presented at the 3rd International Solvothermal and Hydrothermal Association Conference, Austin, TX, Jan. 13-17.